Rocket lab due Friday
Test Energy (chapters 10,11 and some of 12) Thursday, Feb 8th
Questions?

Thermal Physics (Chapter 12)
Define Heat, Thermal Energy, Temperature,

Temperature, T

Measure of coldness or hotness.
microscopic: related to the kinetic energy of the particles (atoms and molecules) that make up an object.
Temperature is the average kinetic energy of the particles that make up an object.
units: degrees Celcius, ºC based on water, water freezes at zero Celcius and boils at 100ºC
Kelvin, K is another temperature scale. It is based on Celcius scale - change of 1ºC = a change of 1K but zero Kelvin is absolute zero where the kinetic energy of the particles is zero.
perfect absolute zero doesn't exist but deep space is pretty close.
absolute zero = -273.15ºC = 0K

Thermal Energy, U
Is the sum of the kinetic energy and potential energies of all the particles that make up an object.
It is a pain to calculate, so we generally don't.

Heat, Q
The change in Thermal Energy of an object.
Measured in Joules, J.
Related to the change in temperature but is also determined by the amount - mass - of the substance, the type of substance and the changes in state (solid to liquid to gas)

$Q=mc\Delta T$
Q is the heat given off or absorbed, in Joules.
m is the mass of the object, in kg.
ΔT the change in temperature, in ºC or K
c is determined by the type of substance, the specific heat capacity, in J/kgºC or J/kgK
look them up in a table

Water, c=4180 J/kgºC
Iron, c= 449 J/kgºC
Gold, c=129 J/kgºC

eg. You put 1.0 litres of water (mass 1.0 kg) on the stove and heat it from 20.0ºC to boiling.

a) what is 20.0ºC in K? what is 100.0ºC?
b) how much heat is required?
c) You put the same mass of gold on the stove, how much heat is required for the same temperature change?

p247 Q1-4 and 248 Q5-8

a) if 0K is -273.15ºC, then 20.0ºC is 20+273.15= 293.2 K and 100ºC is 373.2K

b) $Q=mc\Delta T$=1.0kgx4180J/kgºC(water) x (100-20ºC)
$Q = 1x4180x80=334400\ J = 3.3 \times 10^5 J$

c) $Q=mc\Delta T$=1.0kgx129J/kgºC(gold) x (100-20ºC)
$Q = 1x129x80=10{,}320\ J = 1.0 \times 10^4 J$
way less energy is required for gold

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Define Heat, Thermal Energy, Temperature,

Temperature, T

How hot or cold something is. Macroscopic.

Microscopic definition - when it is hot, the atoms and/or molecules (particles) are moving more.

Units: degrees Celsius, ºC or Kelvin, K
the Celsius scale is based on water freezing at 0ºC and boiling at 100ºC at standard pressure.

The Kelvin scale is based on absolute zero being when the particle stop moving - scale is proportional to the average kinetic energy of the particles. The constant of proportionality is based on the Celsius scale - so a change in temperature in Kelvin is the same as in Celsius.

zero Kelvin is at -273.15ºC - doesn't exist but deep space is pretty close - labs you can get to a small fraction of 1 K.

Thermal Energy, U
Total energy of the particles that make up an object - kinetic energy + potential energies.

It is real pain to work out, so we usually don't. Instead we refer to heat:

Heat, Q

The transfer of thermal energy from a hot object to a cooler object. - Conduction (particles collide), convection gas or liquid moves (hot air rises) or radiation - infrared energy is transferred.

What factors influence the amount of heat given off by an object?

The change in temperature, ΔT, in Celsius or K.
The mass of the object, in kg.
The different particle types and interactions influence the amount of heat required, the specific heat capacity, c, is the energy per unit mass to change the temperature by 1 degree Celsius.
Changes of state influence the potential energy of the particles.

$Q=mc\Delta T$

Q is the heat absorbed or given off by an object, in Joules.
m is mass in kg
ΔT is change in temperature, in ºC or K.
c is specific heat capacity in J/kgK or J/ºCkg

heat capacity you can look up:
water: 4180J/kgºC Iron: 450 J/kgºC

table p248 lead 130 J/kgºC

eg. You put 2.0 kg of water (2 litres) on the stove and heat it from 20.0ºC to boiling.

a) what is 20.0ºC and 100.0ºC in Kelvin?

20+273.15=293.2 K and 373.2K

100-20=80 373.2-293.2=80

b) how much heat is required to bring the water to boil?

Q=mcΔT = 2.0kgx4180J/kgºC(100ºC-20ºC)

2x4180x80=668800 = 6.7×10^5J

c) If you put (same mass of) lead on the stove, how much heat would be required for the same temperature change?

Q=mcΔT = 2.0kgx130J/kgºC(100ºC-20ºC)

2x130x80=20,800 = 2.1×10^4 J`

Homework - rocket lab, p247-248 Q1-8, look over your quiz

Rocket lab due Friday

Test Energy (chapters 10,11 and some of 12) Thursday, Feb 8th

Questions?

Thermal Physics (Chapter 12)
Define Heat, Thermal Energy, Temperature,

Temperature, T
How hot or cold something is.
Microscopic - the atoms or molecules (particles) are moving faster if it gets hotter.
Units: degrees Celsius, ºC and Kelvin, K
The Celsius scale is based on pure water at standard pressure freezing at 0.0ºC and boiling at 100.0ºC.
The Kelvin scale is based on absolute zero, zero Kelvin, where the particles have zero kinetic energy. The temperature is proportional to the average kinetic energy of the particles. The constant of proportionality is based on the Celsius scale, so a change in Kelvin is the same as a change in Celsius.
Zero Kelvin happens at -273.15ºC (actually, it never occurs, you can only get really close)

Big Idea: Temperature is a measure of the average kinetic energy of the particles of an object.

Thermal Energy, U
Is a measure of the total kinetic and potential energies of all the particles that make up an

object.

so, a cup of water and a bathtub of water at the same temperature have particles moving with the same average kinetic energy. The bathtub has way more particles so it has more thermal energy.

Thermal energy is a pain to work with because there are so many particles. Instead we talk more about heat:

Heat, Q
The energy given off or transferred from a hot object to a cooler object, in Joules, J.
What factors influence the heat given off?
Quantity of matter, mass in kg.
The type of stuff - we quantify that experimentally as the specific heat capacity, c in J/kgºC or J/kgK
The change in temperature, ΔT, in ºC or K.

$Q=mc\Delta T$

Q is heat, in J.

c is specific heat capacity find the values on a table p248
water c=4180J/kgK, iron c=450J/kgK lead 130 J/kgK

methanol is 2450 J/kgK

eg. If you put 2.0 kg of water on the stove and heat it from 20.0ºC to boiling and then put the same mass of lead on the stove,

a) what is 20.0ºC and 100.0ºC in K?

20.0 Celsius = 293.2K 100.0ºC = 373.2K

b) what is the heat required to change the temperature of the water?

$Q=mc\Delta T$ = 2.0 kg x 4180J/kgºC x (100ºC-20ºC) = 2x4180x80=668800 = 6.7×10^5J

c) how about the lead for the same change in temperature?

$Q=mc\Delta T$ = 2.0 kg x 130J/kgºC x (100ºC-20ºC) = 2x130x80=20,800 = 2.1×10^4J

p247-248 Q1-8 (rocket lab is due next class) test is Feb 8